

Cryospheric Applications of Landsat-8

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Feature tracking of ice flow

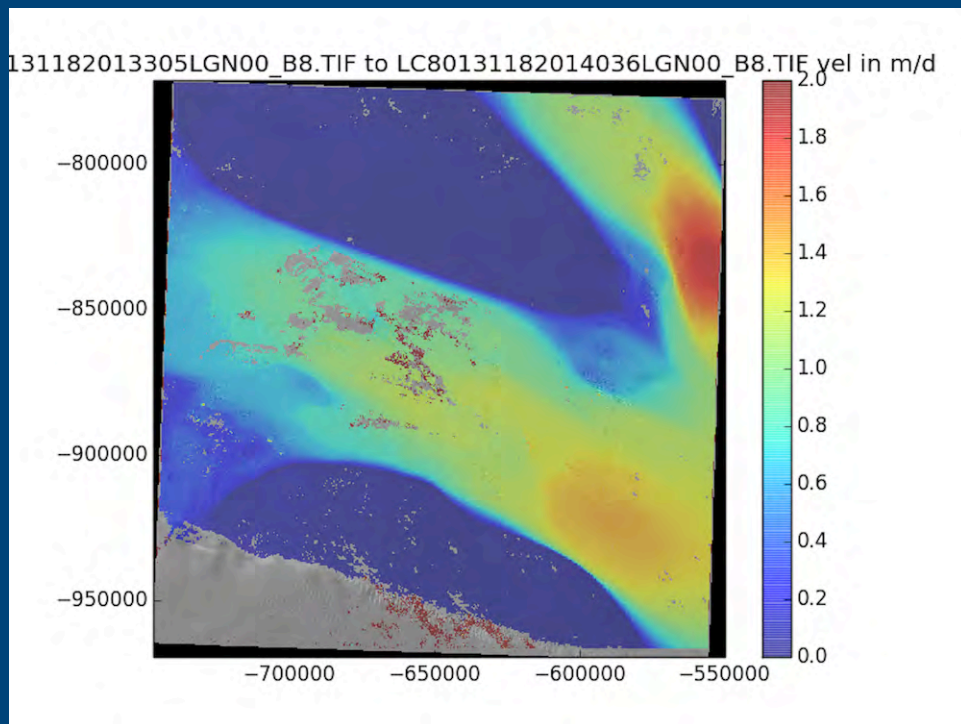
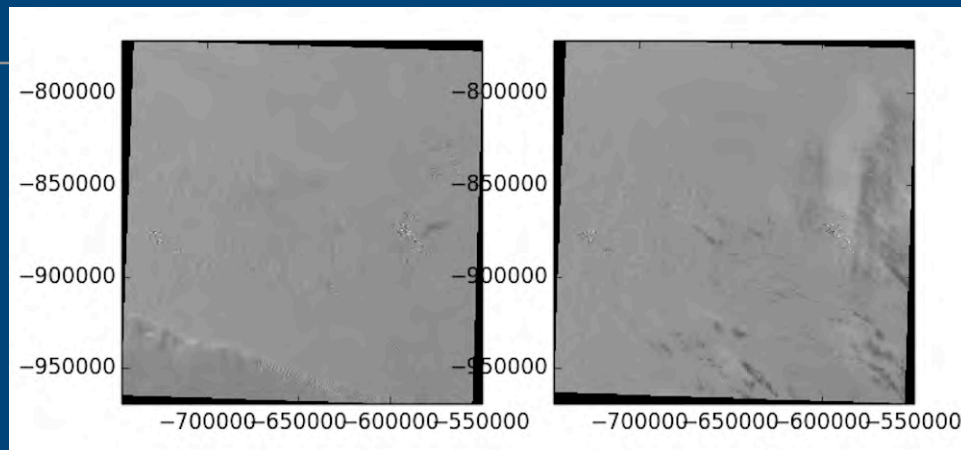
New code makes use of higher radiometric fidelity of L8, and illustrates the high precision of L8 scene geolocation;

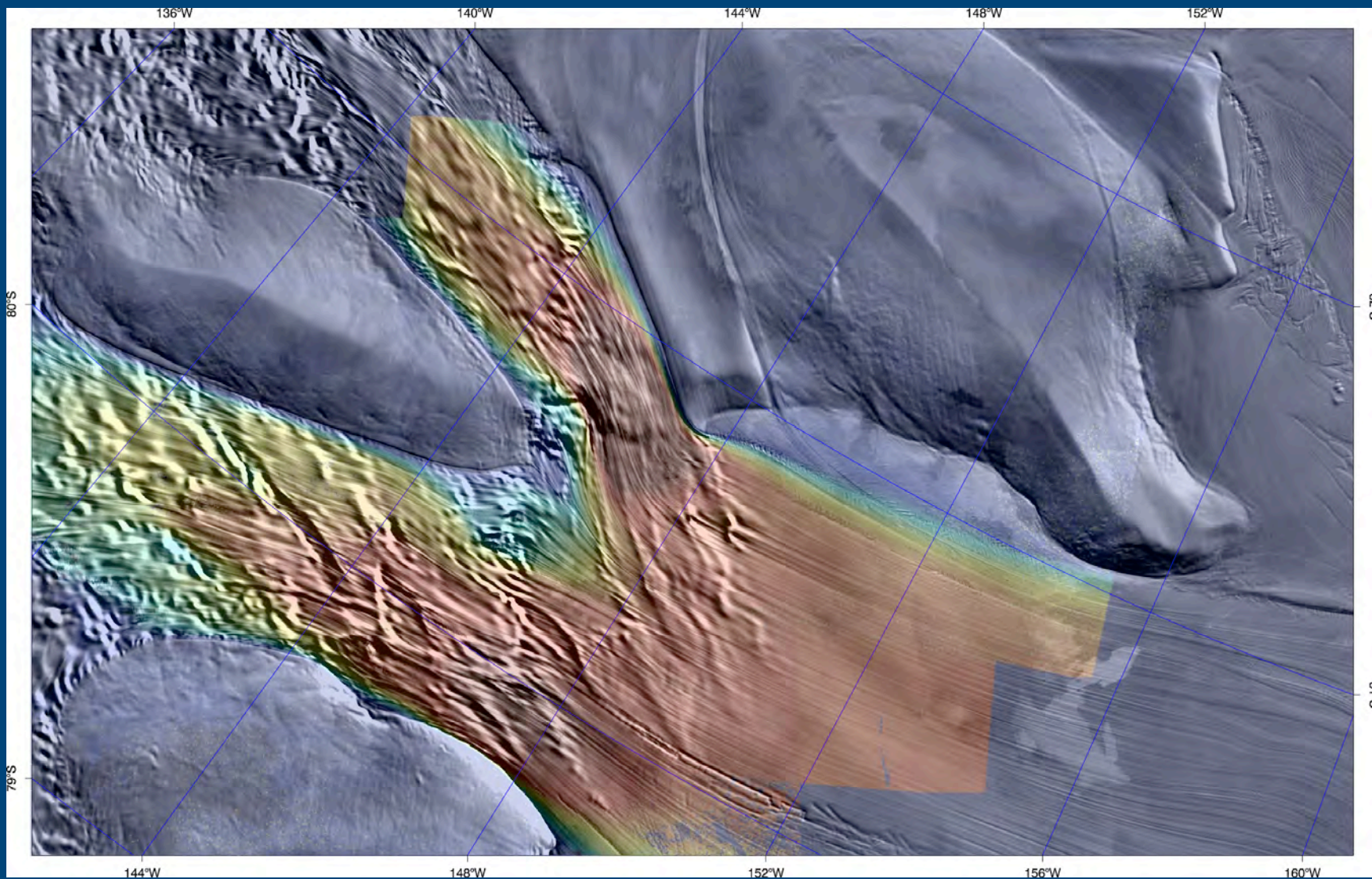
Image-to-image cross-correlation applied to ice motion –
Bindschadler and Scambos, 1991;
Scambos et al., 1992;
Fahnestock et al. 1993

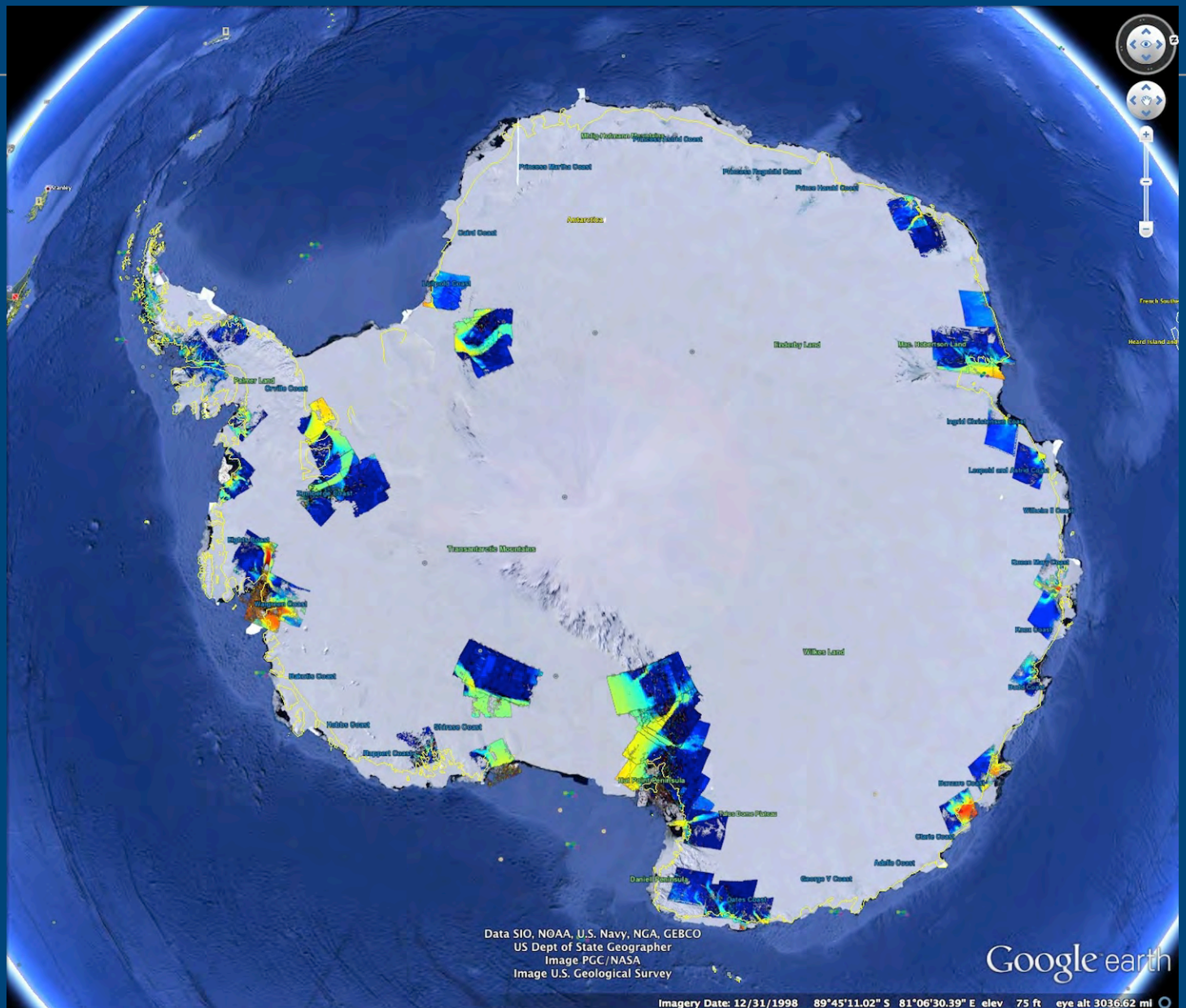
Image pair resolves ice motion to 0.3 pixels displacement, or about 5 meters motion;

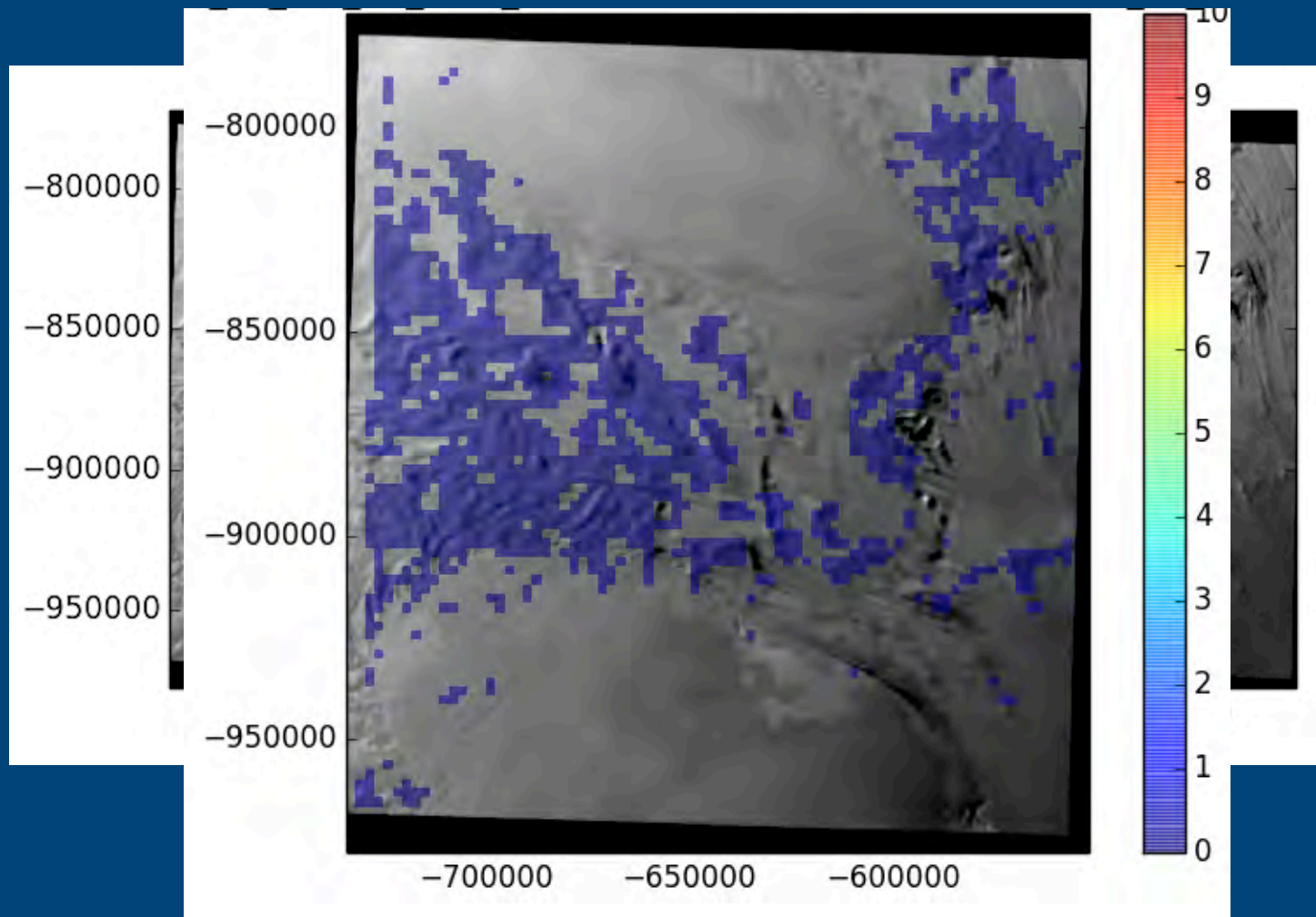
Implied geolocation accuracy in this case is ~2-3 meters.

Software name: **PyCorr** –
Python Image Correlation Engine.









An aerial photograph of a massive glacier flowing through a series of rugged, snow-covered mountain peaks. The glacier's surface is marked by numerous longitudinal stripes of sediment and rock, indicating its long history and movement. The surrounding mountains are partially covered in snow and ice, with some rocky outcrops visible. The sky is a pale, hazy blue.

Main Goals

Promote use of Landsat-8 by the polar and glacier communities

Acquire data that supports wide range of science applications

Conduct a series of key studies, validate new and existing algorithms

Demonstrate effectiveness of the Landsat-8 sensors

Acquisition scheme for ice and glaciers

Current acquisition format is all land areas, varying priorities;

- polar coverage is very frequent due to convergence;
- special requests from PIs or users will be considered;
- end *‘one clear, then next year’* Arctic acquisition plan

Planned ~annual special requests:

Antarctic ascending-node coverage along coast –

Greenland ascending-node coverage along coast –

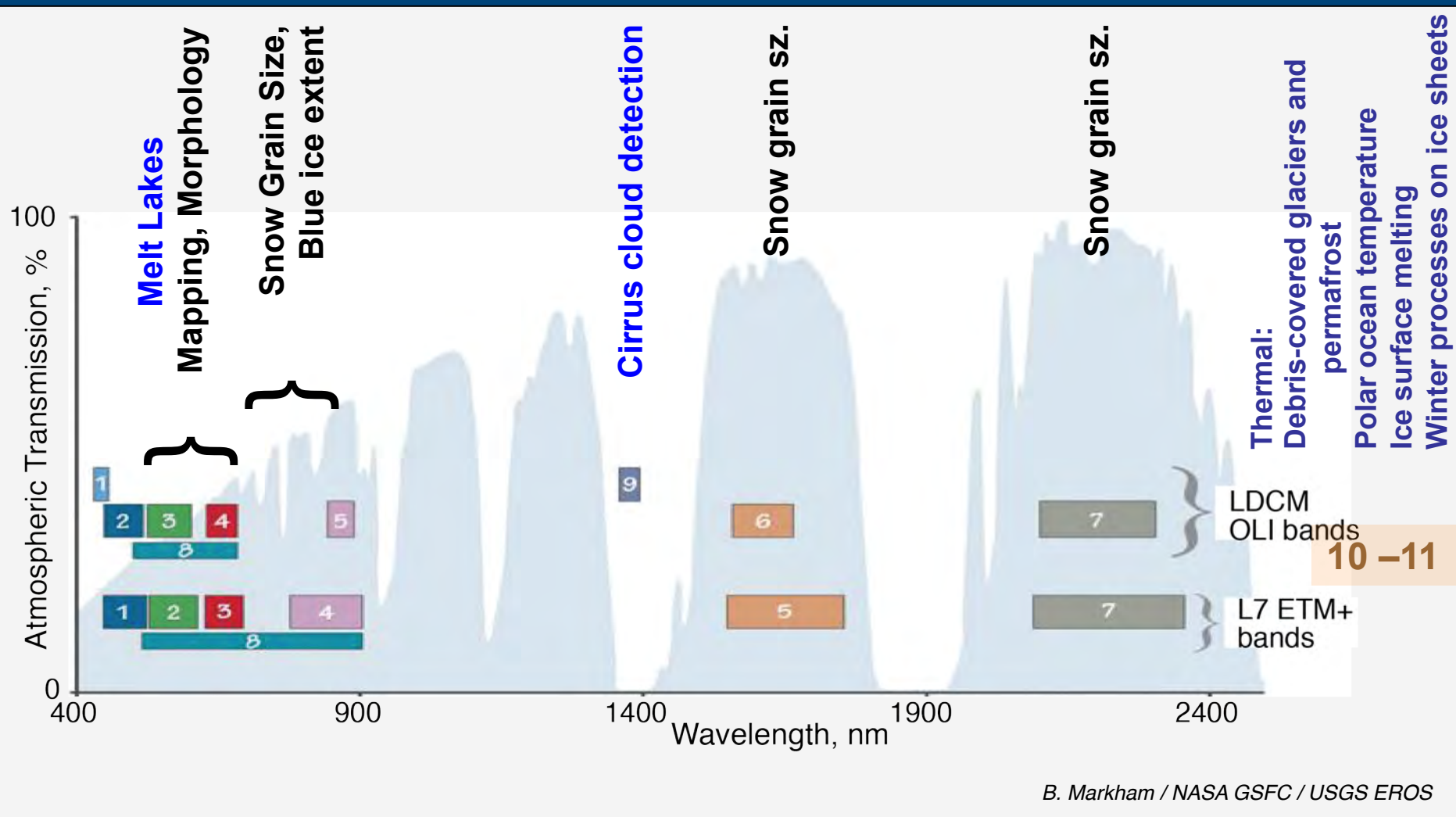
supporting ice velocity and elevation mapping

Sea ice study area north of Alaska and Canada (2 areas)

New targets for thermal channel (polar night, ascending node):

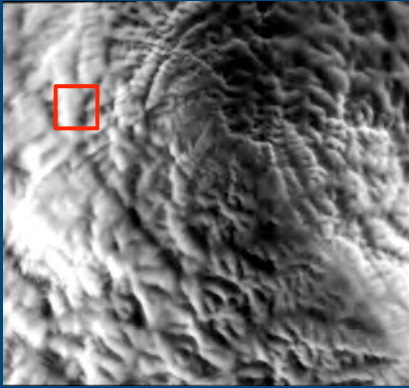
permafrost, debris-covered glaciers, ice sheet coastlines,
Antarctic winter target for extreme low temperatures.

Snow and Ice and the Landsat 8 bands



B. Markham / NASA GSFC / USGS EROS

Thermal mapping of the East Antarctic interior in winter



Pushbroom sensor noise in thermal channels at low T is significant;
Destriping filter scheme used to extract noise semi-quantitatively

Path 094, Row 120, 02 June 2013;
near Dome A, Kunlun Station, Antarctica

GGC Sun Oct 27 20:38:00 MDT 2013 Raw.153.B10

Original sub-scene

GGC Sun Oct 27 20:35:36 MDT 2013 NA=19 NB=17 NC=101 153.B10

Extracted noise

Std dev 1.7 K

101 x 17 x 19 filter kernels

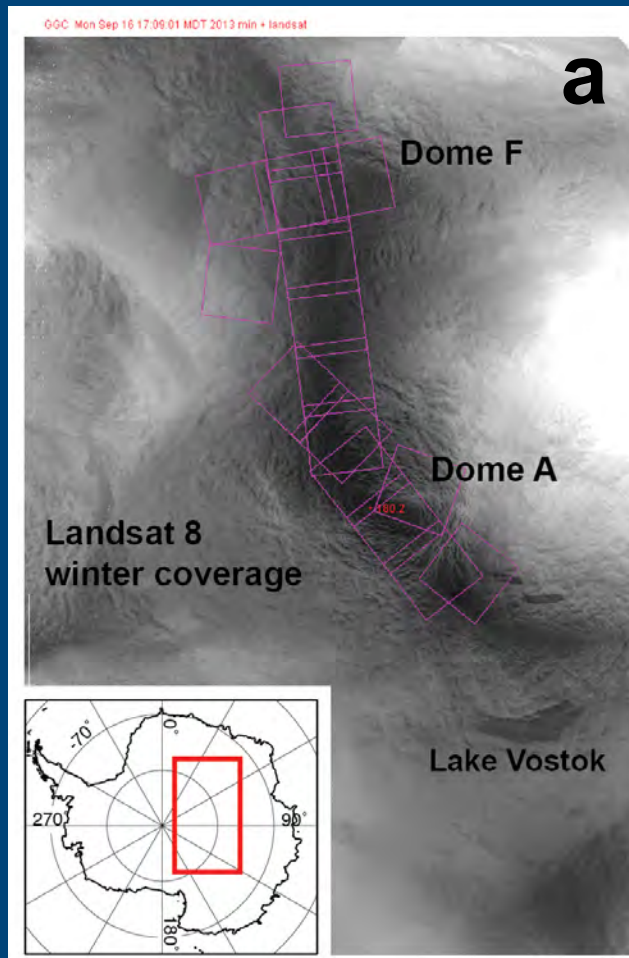
GGC Sun Oct 27 20:36:49 MDT 2013 NA=19 NB=17 NC=101 153.B10

Noise-reduced scene

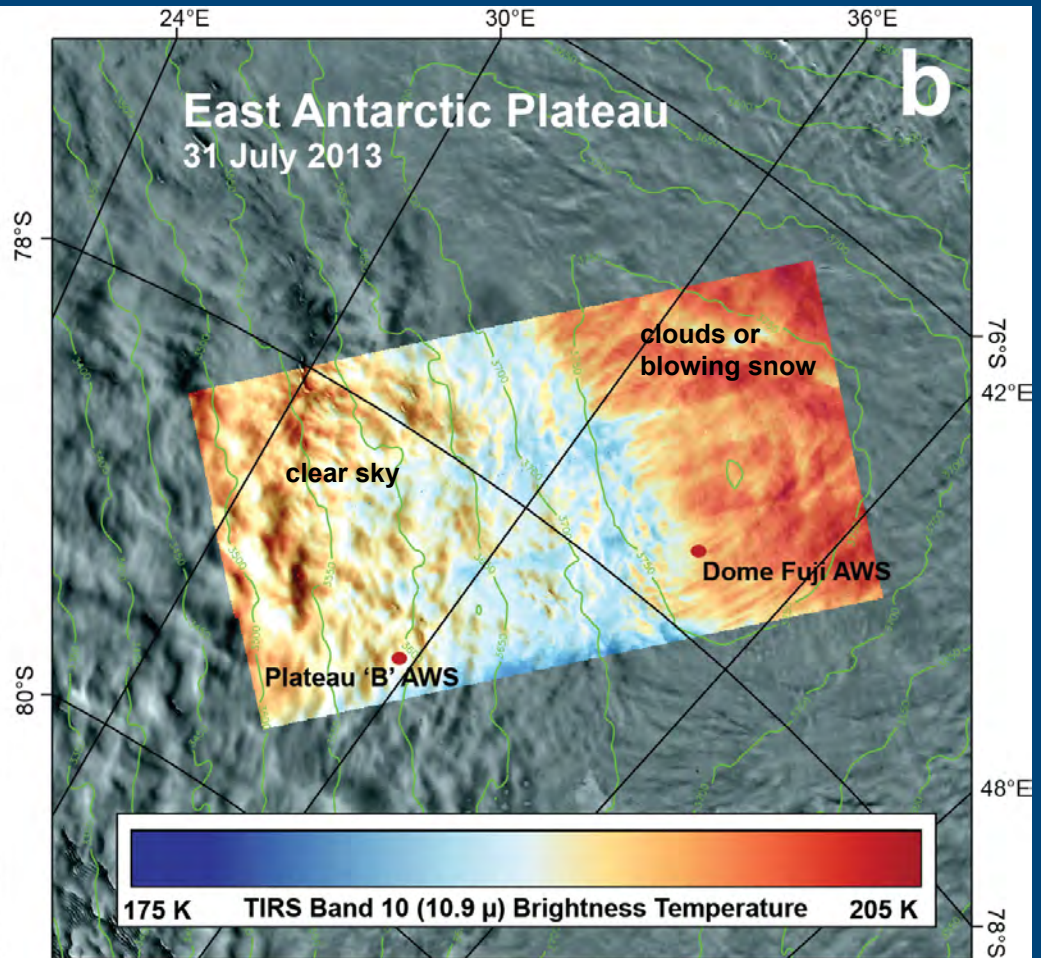
Crippen, PE&RS 1989 filtering (modified)

Thermal mapping of the East Antarctic interior in winter

MODIS LST minimum T, 2013



surface image with Landsat 8 B10 color scale BT

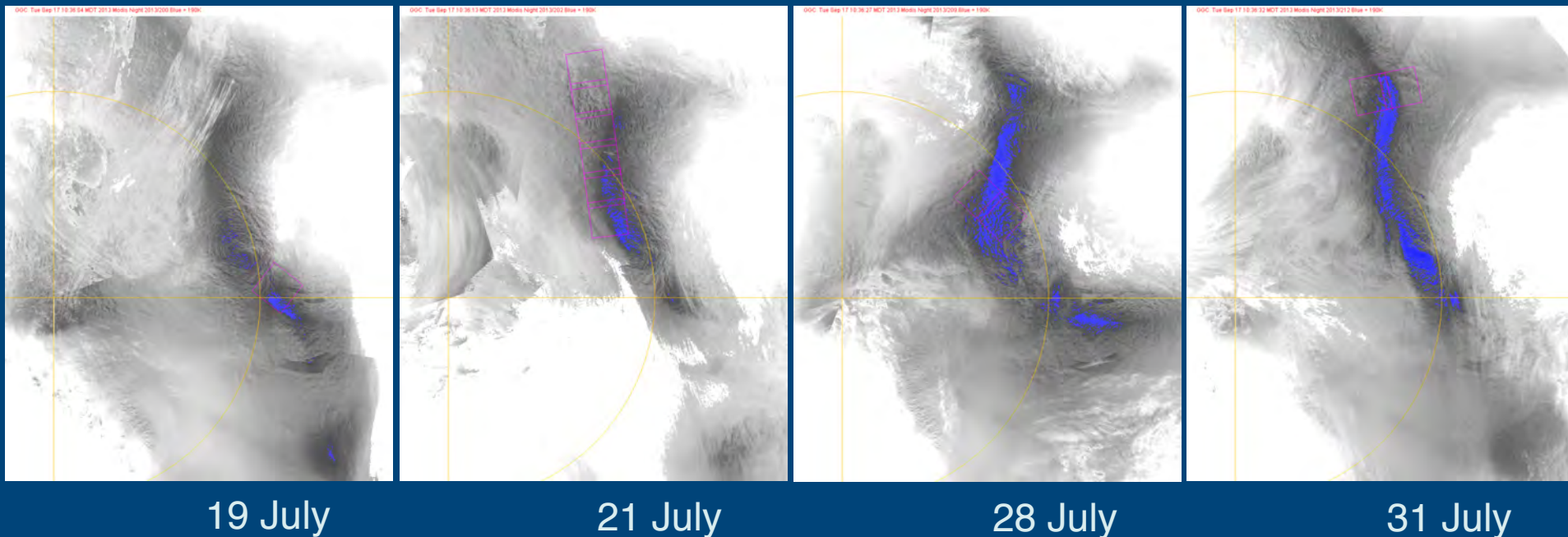


Purple outlines are Landsat 8 acquisitions June-August 2013

Thermal mapping of the East Antarctic interior in winter

Cold mid-winter temperatures occur near an ice divide crest under clear-sky conditions; Radiative surface cooling, and light winds; coldest temperatures occur in ~2-4 km wide hollows caused by ice flow and wind erosion.

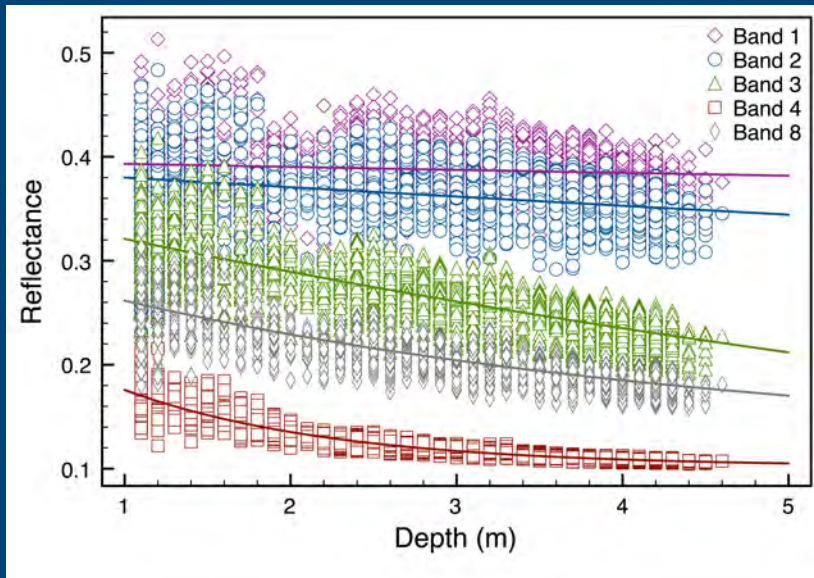
MODIS Aqua 'night' Land Surface Temperature (blue = < 190 K)



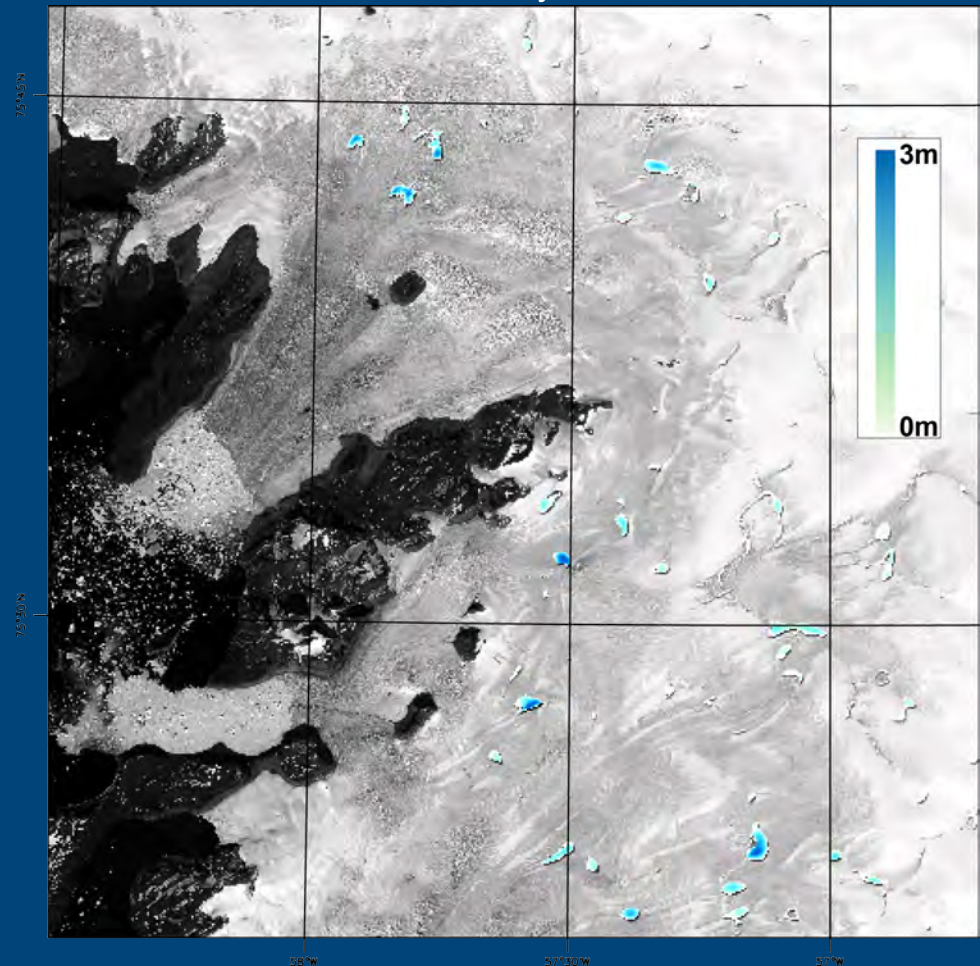
Purple outlines are Landsat 8 acquisitions June-August 2013

Melt lake depth mapping using Landsat 8

Field data emulation of OLI bands:



northwestern Greenland, July 18 2013

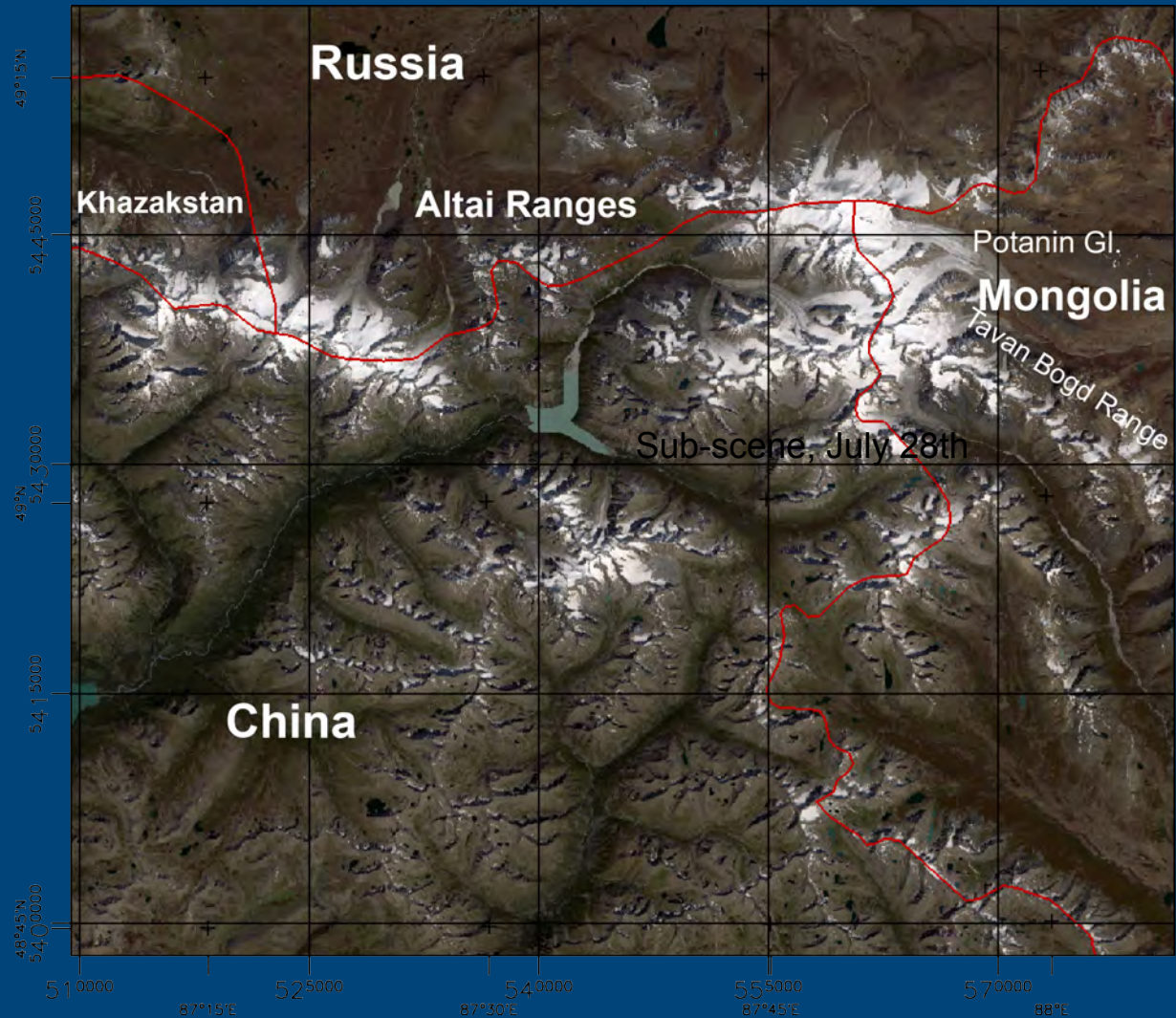


Two approaches:
extinction in single band (gr, B3, pan band, B8)
band ratio (coastal, B1, and green, B3)

Glacier extent/ flow/ change analysis: Altai, Mongolia, and north-central Asia

North-central Asia glacier region is relatively under-studied for glacier change

- Collaborators have used Landsat archive to map extents, 1970 – 2003;
- new work with Landsat 8 will re-map extents, glacier facies, and ice flow.
- We are evaluating the overlap of glacier ice with ICESat laser altimetry in this region.



Landsat-8 Cryosphere group

- **Ted Scambos** (PI) is a **Senior Research Scientist at NSIDC, a part of University of Colorado**; ice sheet mapping, polar field geophysics, climate change in polar regions, sea ice processes
- **Allen Pope**, **post-doc now at NSIDC**; spectral mapping of mountain glaciers; polar remote sensing
- **Robert Bindshadler** (Co-I, contractor) is an **emeritus scientist for NASA** affiliated with the Cryospheric Sciences group at GSFC
- **G. Garrett Campbell**, Research Scientist, NSIDC
- **Terry Haran**, senior programmer and geospatial mapping, NSIDC
- **Mark Fahnestock**, Research Professor, UAFairbanks
- **Marin Klinger**, planned new hire for VELMAP processing

Questions?



Potential LDCM studies

Snow grain size and blue ice extent on ice sheets from LIMA / MOA

Morphology of ice sheets and ice shelves
(comparison of 'sensitivity' to past sensors)

Feature tracking w/ Landsat legacy comparison

Lake extent, depth, and volume in western Greenland / AP

Image differencing and sub-ice-sheet water movement

Photoclinometry / shape-from-shading at grounding line and interior undulation

Thermal mapping of polar ice sheets, winter inversion layer, ocean SST at the ice fronts.